

Seaplanes within a Seabase Environment

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Outline

- Project Overview
- Background
- Characterisation of Seaplanes
 - Parametric Study
 - Rough Water Operations
- Seaplane / Seabase Integration
- Seaplane Concept
- Summary



Seabasing Innovation Cell Team



Team



- **Jessaji Odedra** : UK MoD DESG
- **Geoff Hope** : UK MoD DESG
- **Brent Lindon** : US Acq. Intern
- **Bill Horn** : NAVAIR
- **August Bellanca** : NAVAIR
- **Ms Carey Matthews** : NAVAIR
- **Dr Colen Kennell** : NSWCCD
- **LCdr Russell Peters** : Can Navy
- **Mark Selfridge** : UK MoD

Sponsors/Mentors - External

- Rear Admiral Jay Cohen, CNR
- Rear Admiral Paul Sullivan, NAVSEA
- Mrs Sharon Beermann-Curtin, ONR

Mentors - NSWCCD Carderock

- **NSWCCD - Expeditionary Logistics**
 - Jack Offutt
 - Mrs Kelly Cooper

Industry & Academia Contacts

- USN Museum at WNY
- National Air & Space Museum
- Shin Meiwa Industries
- Beriev Aircraft Company
- SNAME Panel SD-5
- SAIC
- Dr. Dan Savitsky, SIT





Seabase Vision





Project Overview

Objectives

- Enhance capability & seaplane awareness
- Explore suitable platforms to :-
 - enable '**force closure**' ~ seabase / shore arrival & assembly of force
 - meet other potential mission roles ~ **in-flight refueling**
- Study seaplane performance & characteristics
- Identify technology capability gaps for 2010+

Sponsor



Method / Timeline

	Aug	Sep	Oct	Nov	Dec	Jan
Literature search						
Characterization						
Tech extrapolation						
Develop concepts						
Assess S&T reqts.						

Deliverables/Outputs

- Seaplane database available for parametric studies of seaplanes
- Design concepts of potential seaplanes & interfacing with seabase identified
- Document research through technical paper
- Assessment of technology requirements for 2010+ identified



Seaplane Background

Background

Types of Seaplane



Utilization of Seaplanes

- Military
 - fighter, bomber/patrol, ASW, trooper
- Commercial
 - passenger, cargo, leisure & commuting
- Multipurpose
 - firefighting, search / rescue, & medivac



fighter



firefighting



passenger



trooper



cargo

Background

Other forms of seaplanes (landing gear systems)



Convair Seadart



Stroukoff YC-123E



De Havilland XC8a Buffalo

Bell ACLS



Bell ACLS

- Ski
- hydraulic jacks / pantograph
- retractable skis
- amphibious

- Hydrofoil
- retractable hydrofoil

- Air Cushion
- air-bag cushion
- amphibious

Background

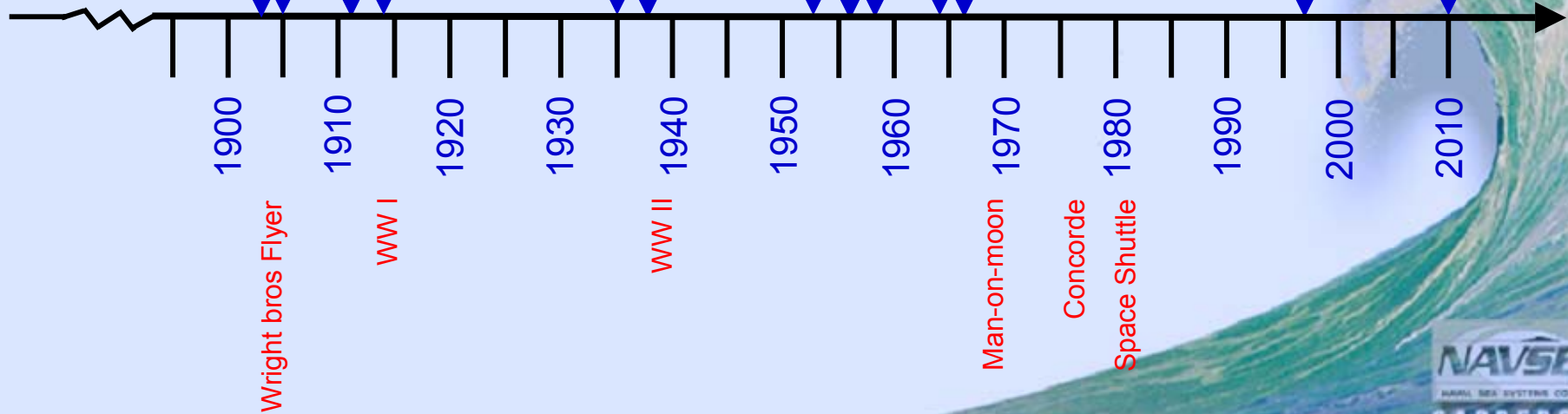
Development of Seaplanes ~ Timeline

Concept – Boeing Ultra pelican



1903 - Wright bros Flyer

Concept - LM C130 floatplane



Background

The rise and fall of Seaplanes

Seaplane Development

- Initiated through **flight development** & military needs
- **Commercialization** ~ global civilian passenger transport



Convair XF2Y-1 Seadart



Martin P6M Seamaster



Convair R3Y Tradewind

Decline of Seaplanes

- **Surplus** war airfields ~ lack of sea-port terminals/infrastructure
- **Improved land aircraft** & equipment
- Maintenance issues
- Reduced military **interest** for seaplanes

Importance of Seaplanes

- **Airfield** shortages near cities
- Poor **reliability & efficiency** of **land planes** in comparison to seaplanes
- **Safety** for over-water flights

Renewed Interest in Seaplanes

- Improved **speed & range** (aerodynamic hulls & light materials for airframe)
- Better maintenance on ground & cargo handling techniques

1950's

Background

Rich USN Seaplane Legacy

- Operated seaplanes ~ +50 years
- Thousands in service

PBY Catalina

217 - PB2Y Coronado

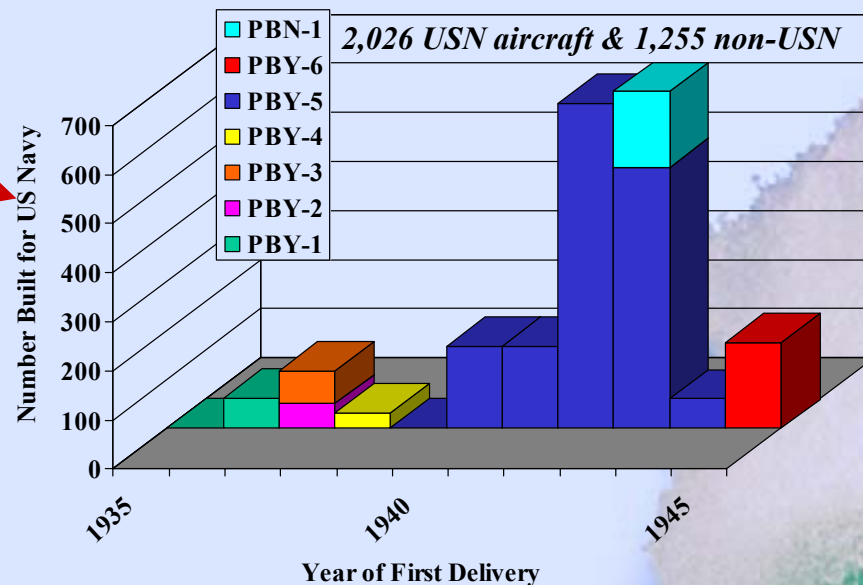
1,366 - PBM Mariner

284 - P5M Marlin

464 - HU-16 Albatross

6 - JMR Mars

11 - R3Y Tradewind





Characterization of Seaplanes

Characterization of Seaplanes

Literature Search



Seaplane Database

- 244 Seaplanes
- Time period: 1910 – 2003
- MTOW: 1000 lbs – 400,000 lbs
- Range: 100 miles – 11,000 miles



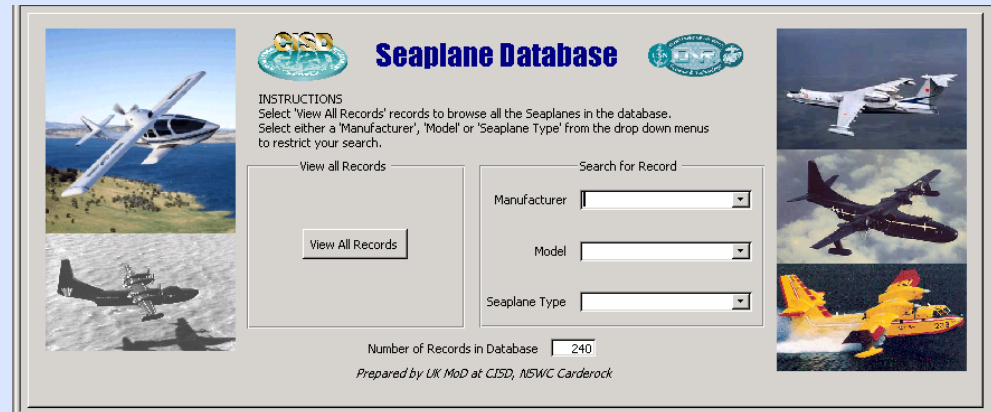
Parametric Study

- Understand Seaplane capabilities
- Identify opportunities
- Aid in Seaplane Conceptual Design



Advanced Concepts

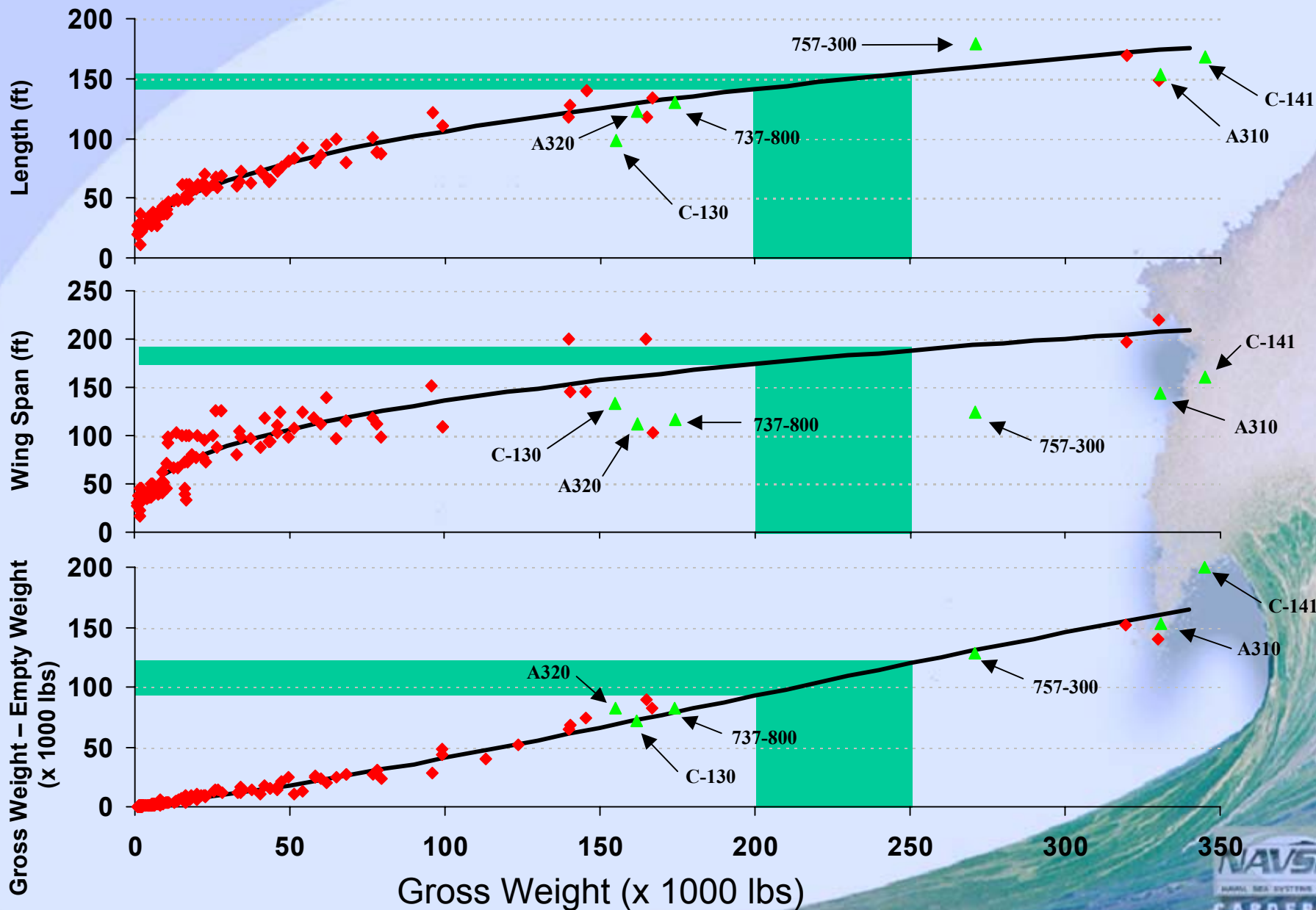
- Identify Science & Technology requirements



The screenshot shows a web interface titled "Seaplane Database". It features a header with logos for the Department of the Navy and CISD. The main content area includes instructions: "Select 'View All Records' records to browse all the Seaplanes in the database. Select either a 'Manufacturer', 'Model' or 'Seaplane Type' from the drop down menus to restrict your search." Below this are search filters: "View all Records" (with a button), "Manufacturer" (dropdown), "Model" (dropdown), and "Seaplane Type" (dropdown). A "Search for Record" button is also present. At the bottom, it shows "Number of Records in Database" as 240 and "Prepared by UK MoD at CISD, N5WC Carderock". The interface is decorated with images of various seaplanes.

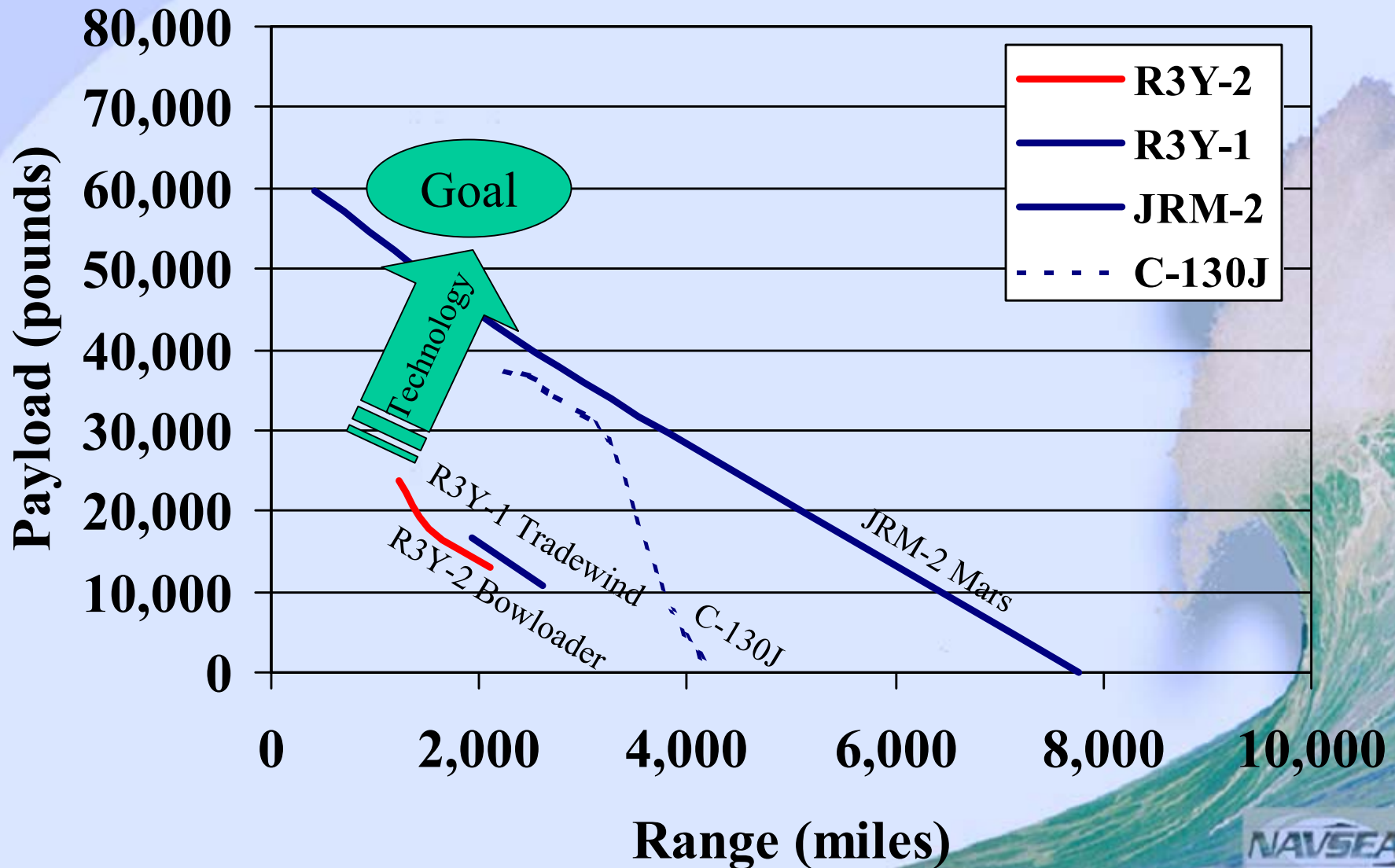


Parametric Study

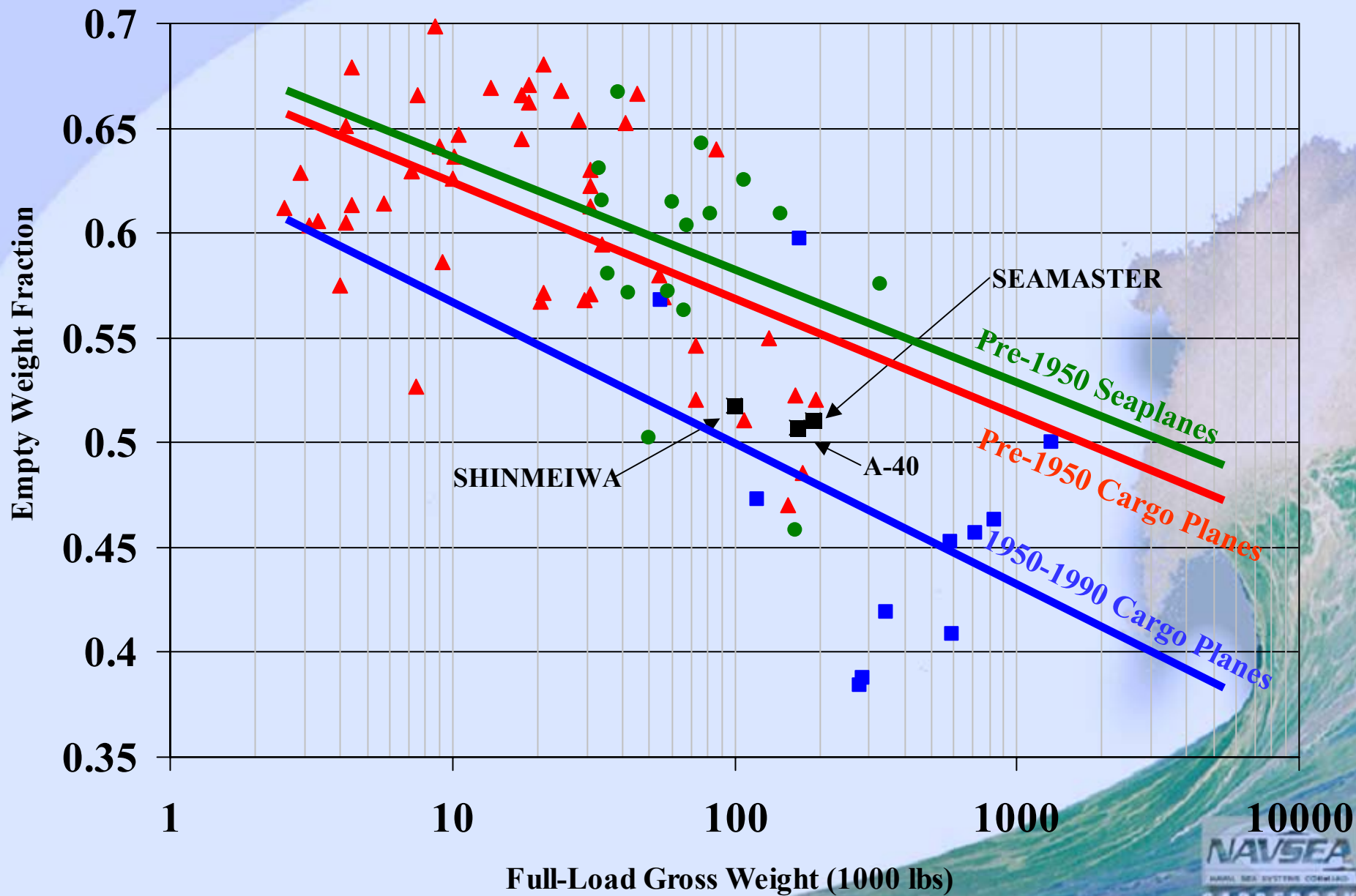


Parametric Study

RANGE - PAYLOAD



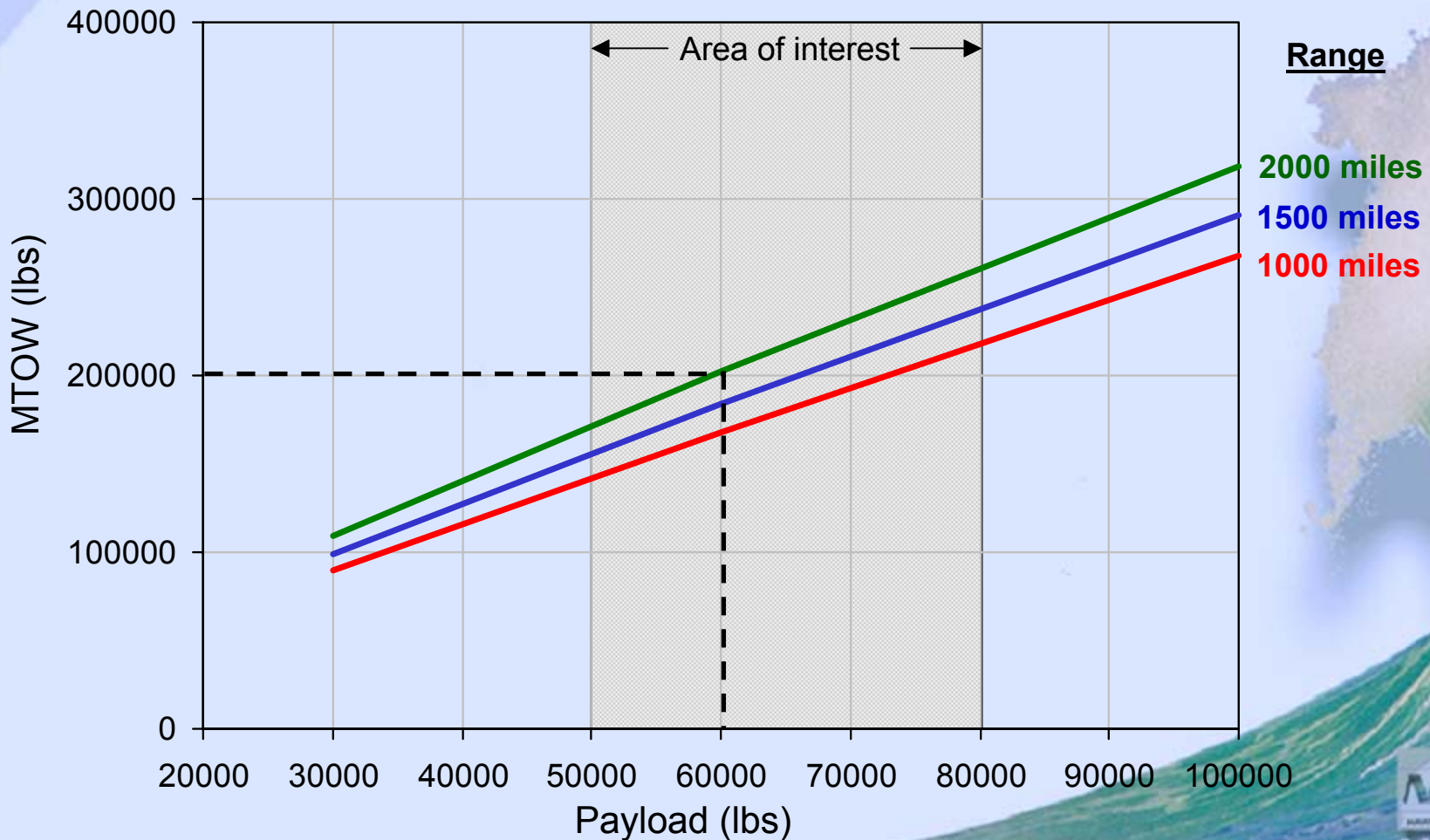
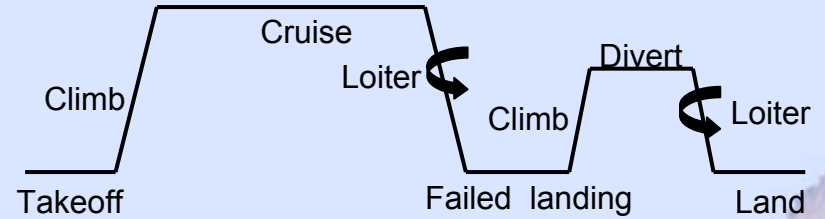
Empty Weight Fraction



Parametric Study

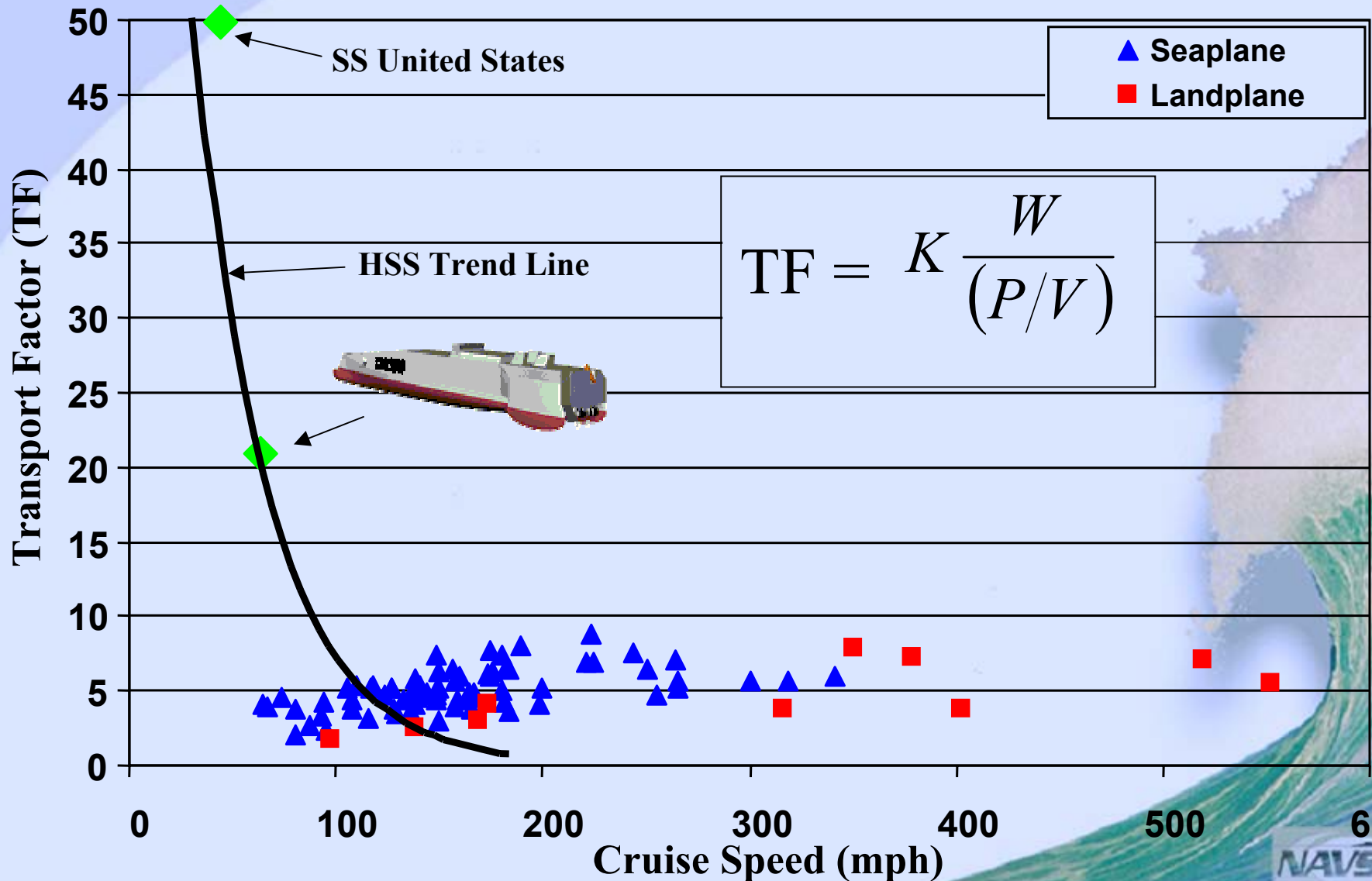
SEAPLANE INITIAL SIZING

$$W_0 = \frac{W_{\text{pax}} + W_{\text{payload}}}{1 - \left(\frac{W_{\text{fuel}}}{W_0} \right) - \left(\frac{W_{\text{empty}}}{W_0} \right)}$$



Parametric Study

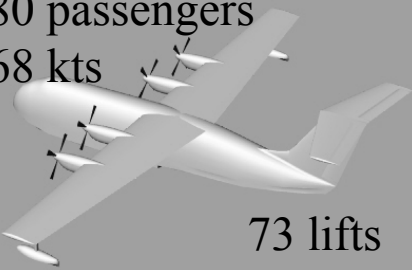
Transport Factor - Speed



Parametric Study

Time to Deploy

180 passengers
368 kts



73 lifts

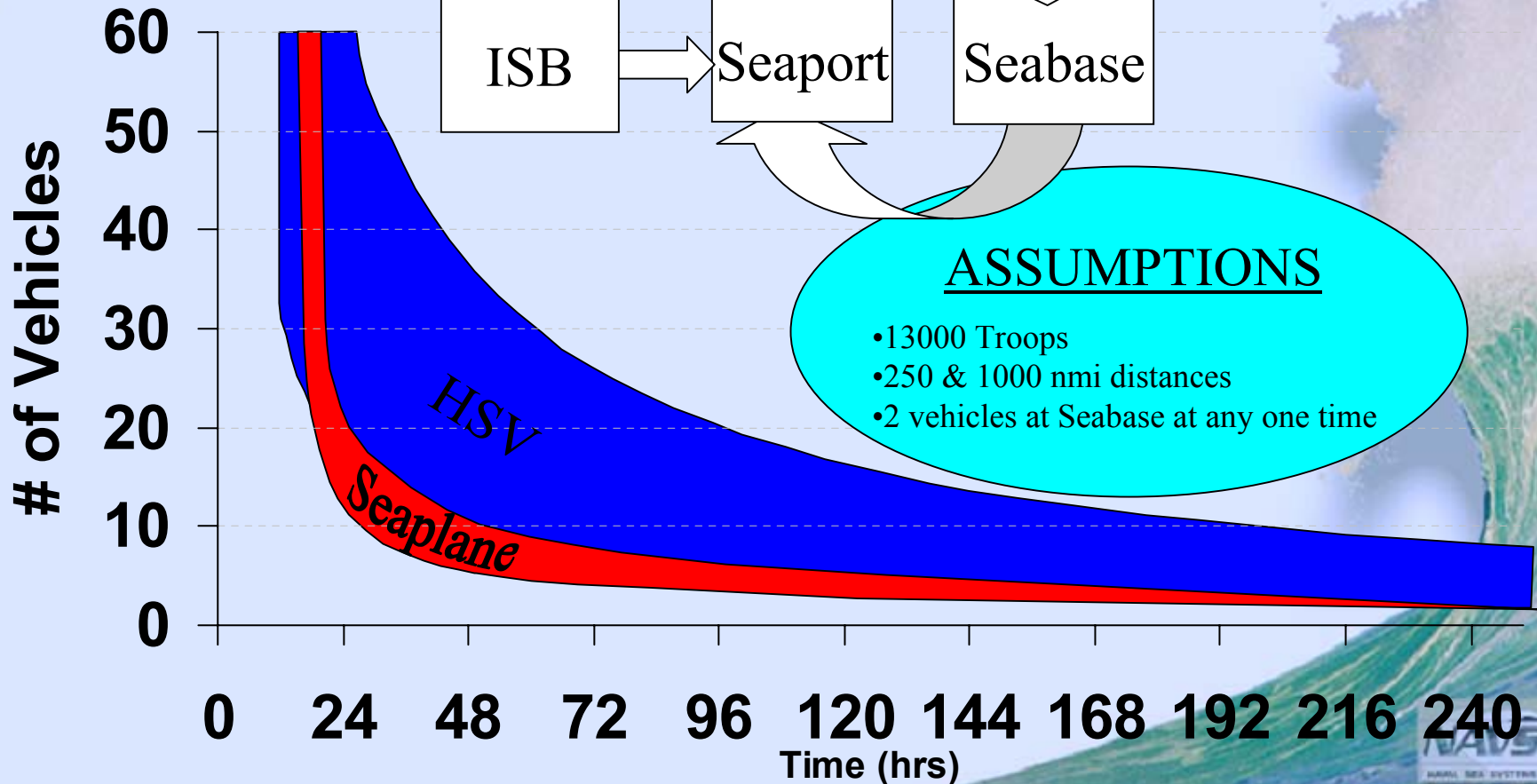
308 passengers
40 kts



43 lifts

Seaplane

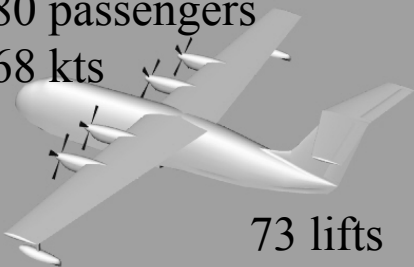
HSV



Parametric Study

Time to Deploy

180 passengers
368 kts



73 lifts

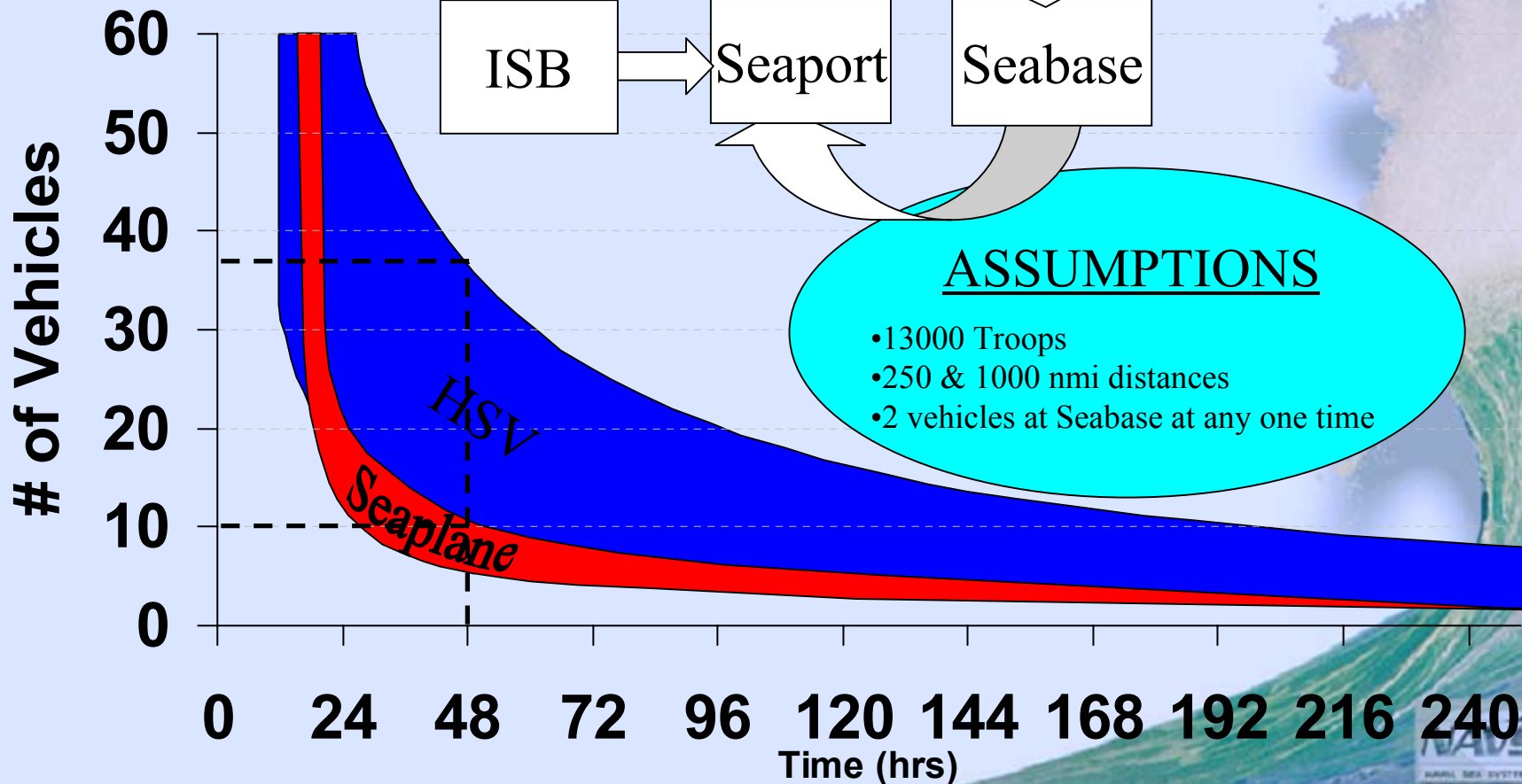
308 passengers
40 kts



43 lifts

Seaplane

HSV

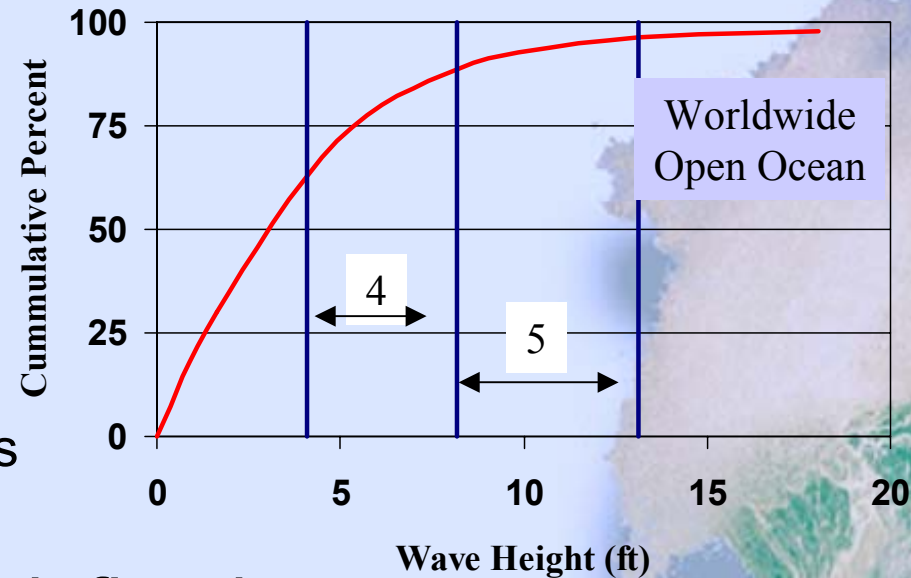




Rough Water Operation

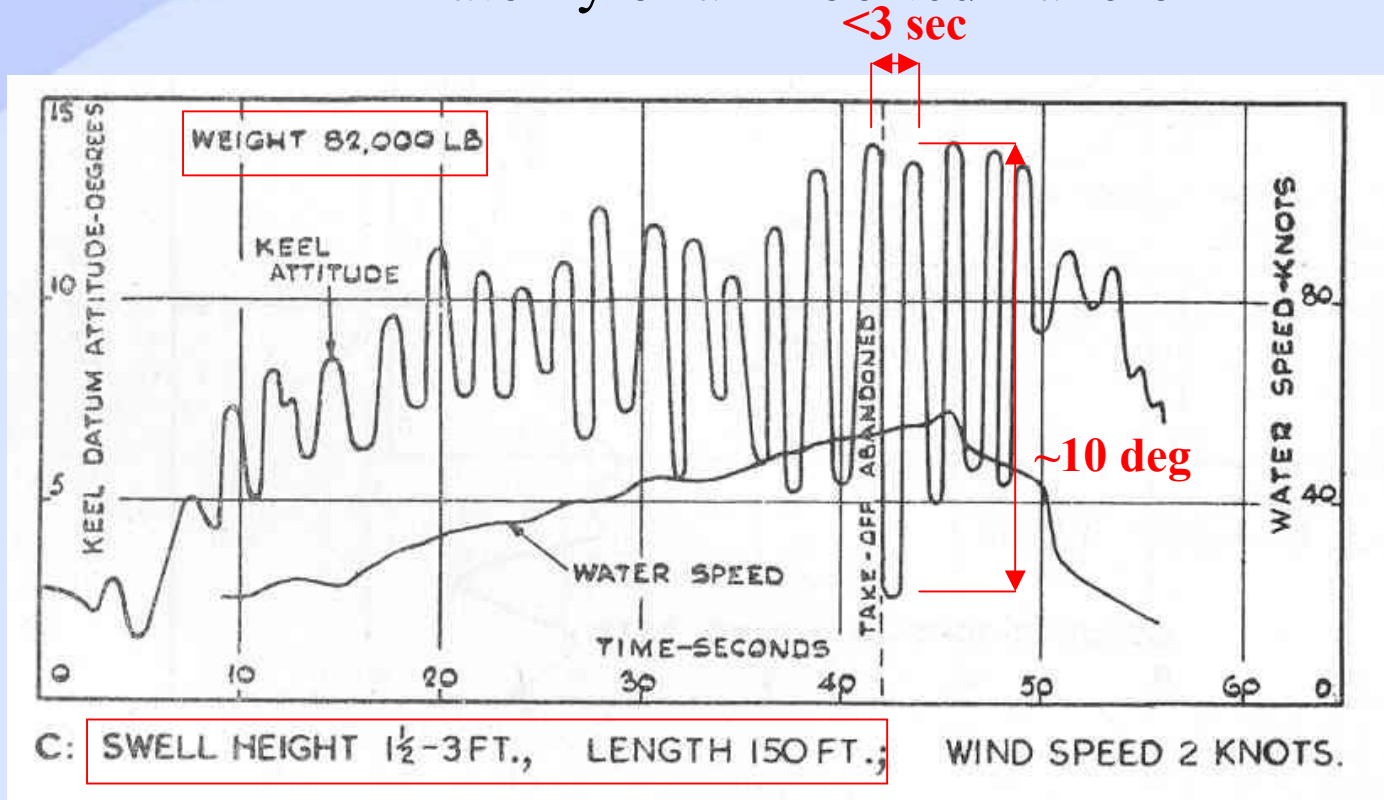
Rough Water Operation

- Reliable rough water operation is crucial
 - Take-off
 - Landing
 - Taxiing
 - Load/unload
 - Survival
 - Demonstrated in gales
 - Appropriate mooring systems
- Required operability is undefined
 - Operations through SS 4 selected as target
- Good rough water performance data is scarce



Rough Water Operation

Anatomy of an Aborted Take-off



*“Porpoising worst when stability limits close together
& porpoising frequencies = rate of striking crests”*

Perception – consequences of loss of control are critical

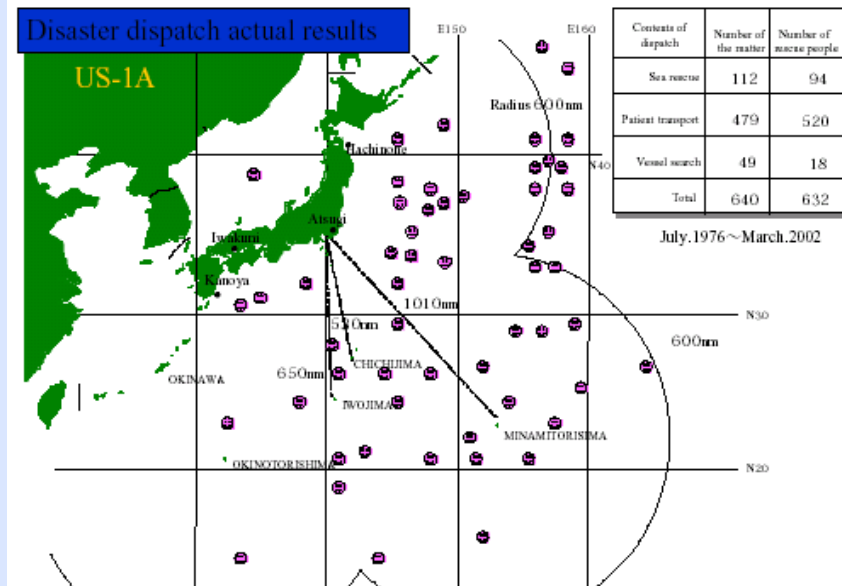
- Plow-in
 - Stall
- Crash

Shin Meiwa US-1A



Characteristics

MTOW (lbs)	
- sheltered water	94,800
- open ocean	79,400
Speed (knots)	230
Range (nm)	2,300
Mission	SAR



Technology

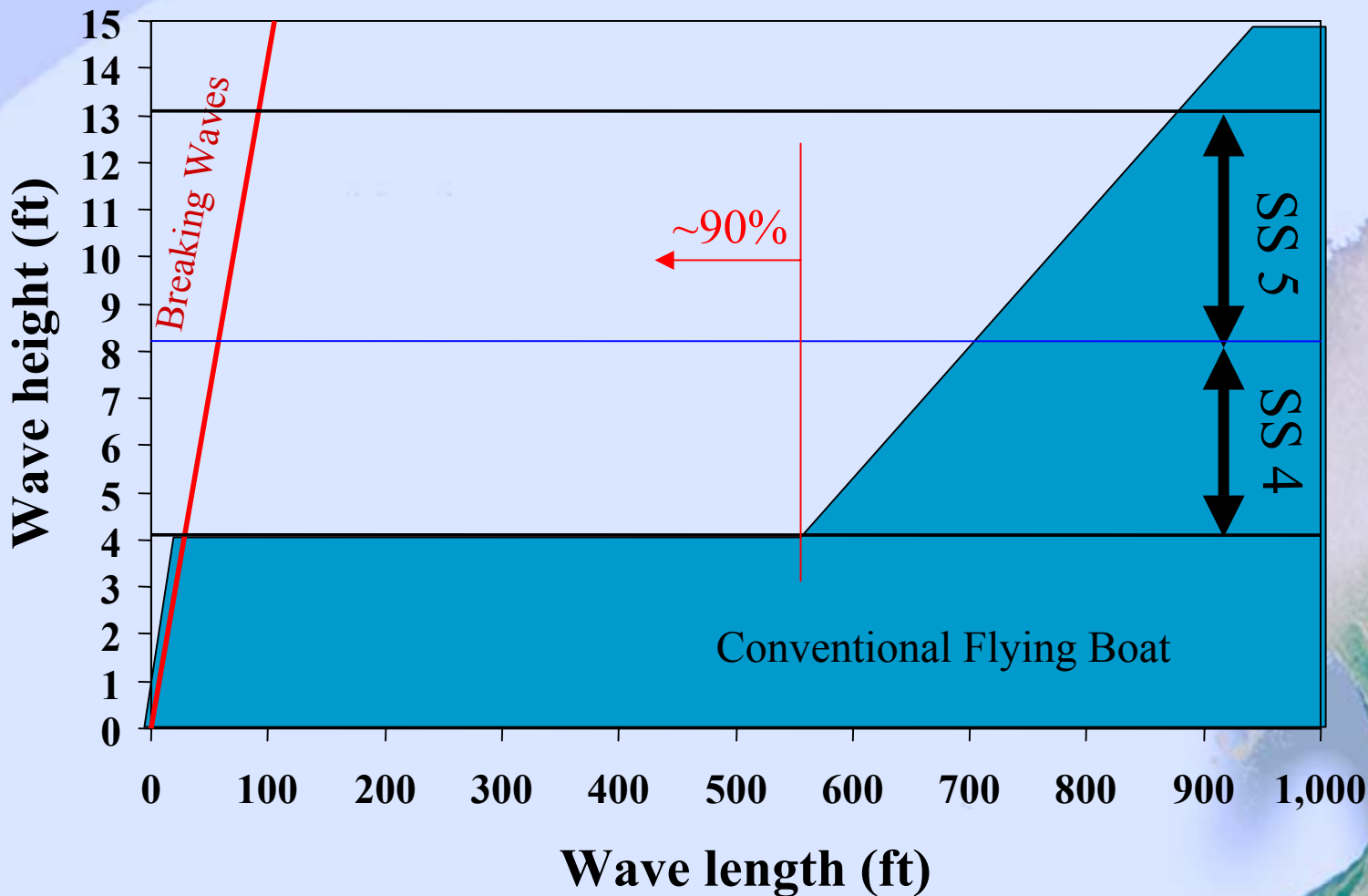
1967 delivery

Hull

- slender hull
- spray suppression systems
- STOL
- blown flaps, rudder, elevator

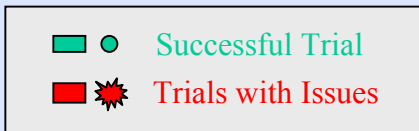
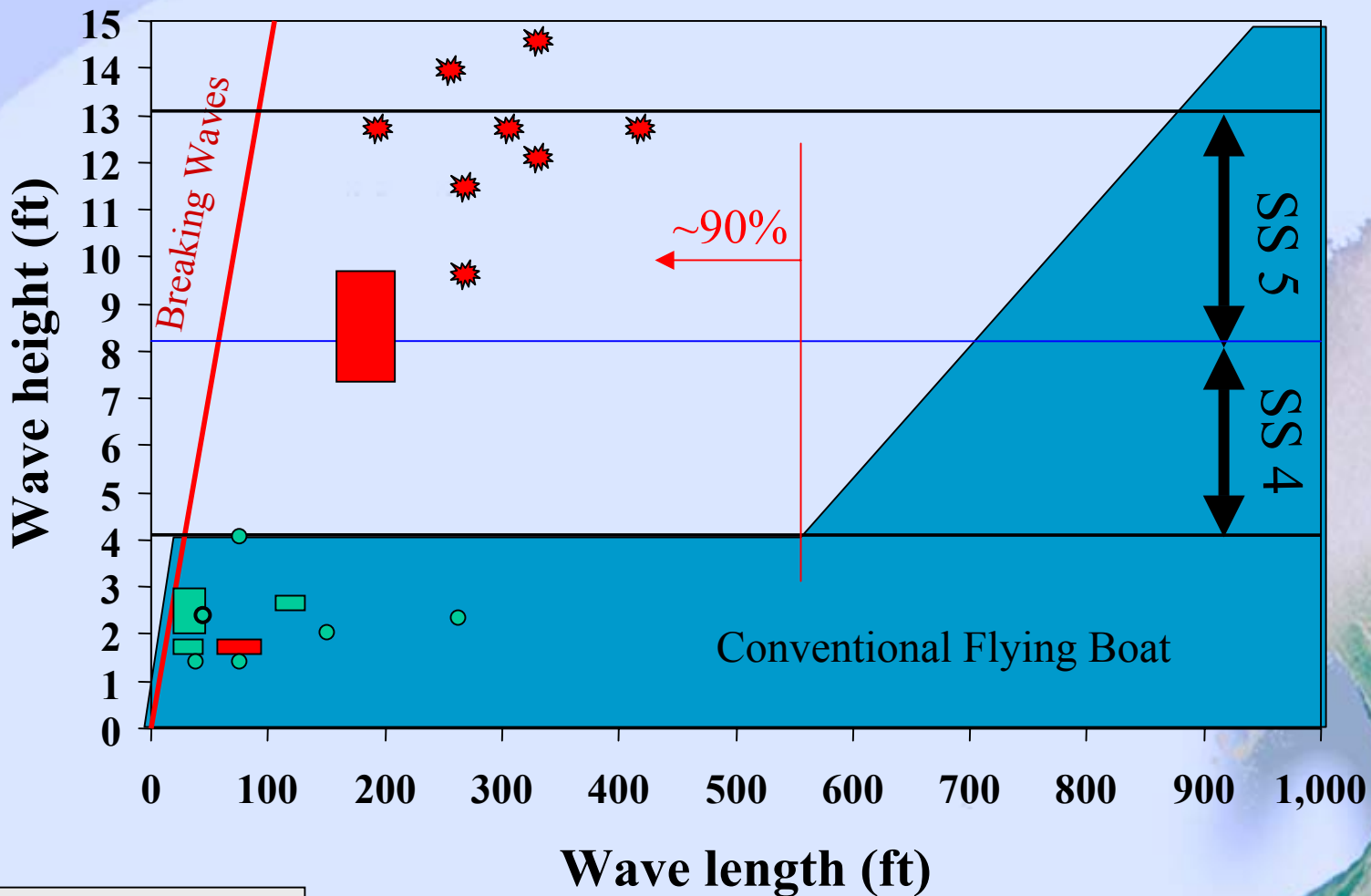
Operating Limits

Shin Meiwa US-1A - 79,000 lb Aircraft



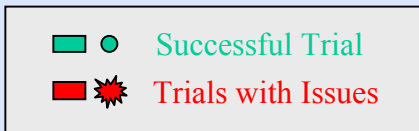
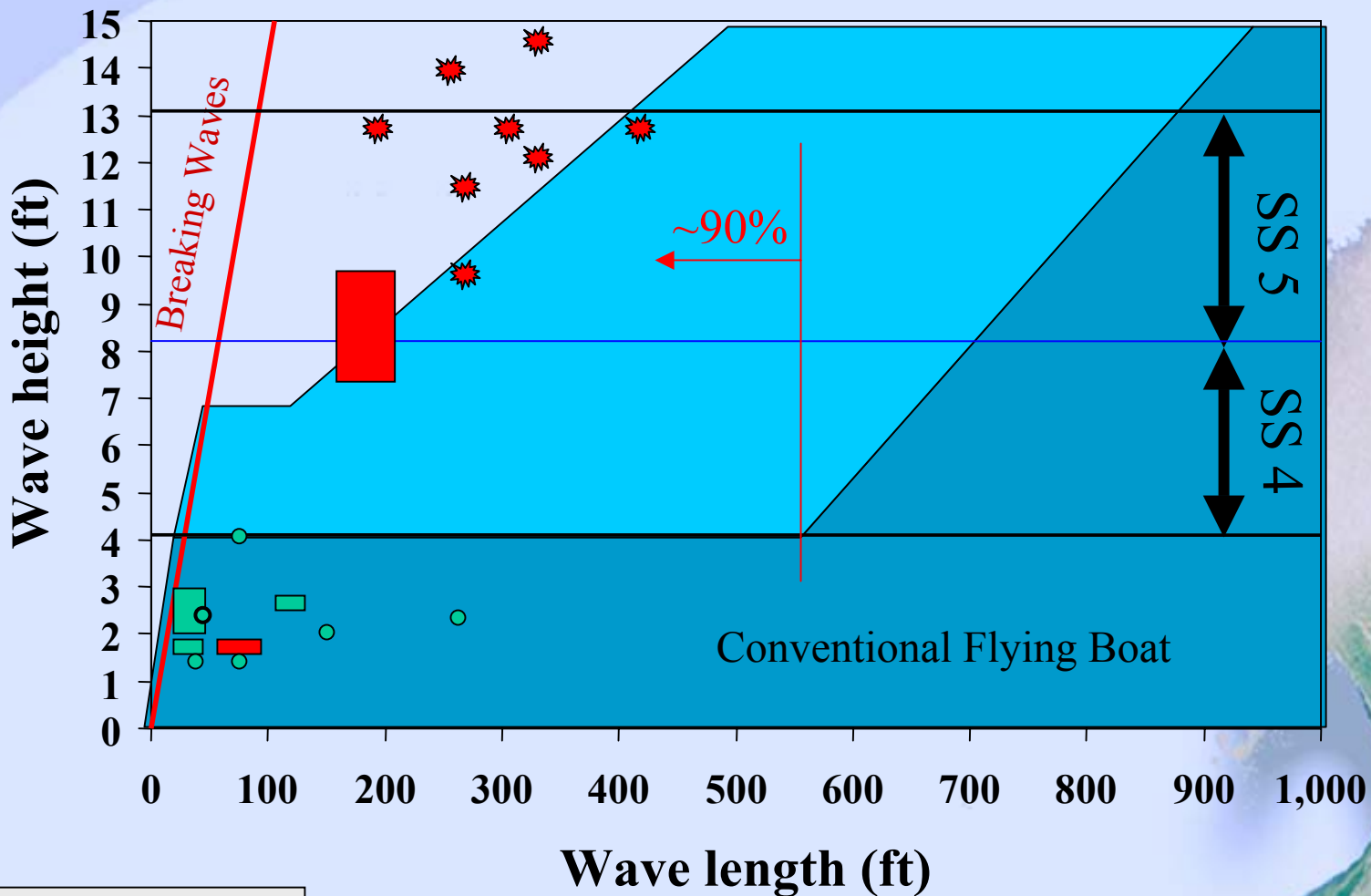
Operating Limits

Shin Meiwa US-1A - 79,000 lb Aircraft



Operating Limits

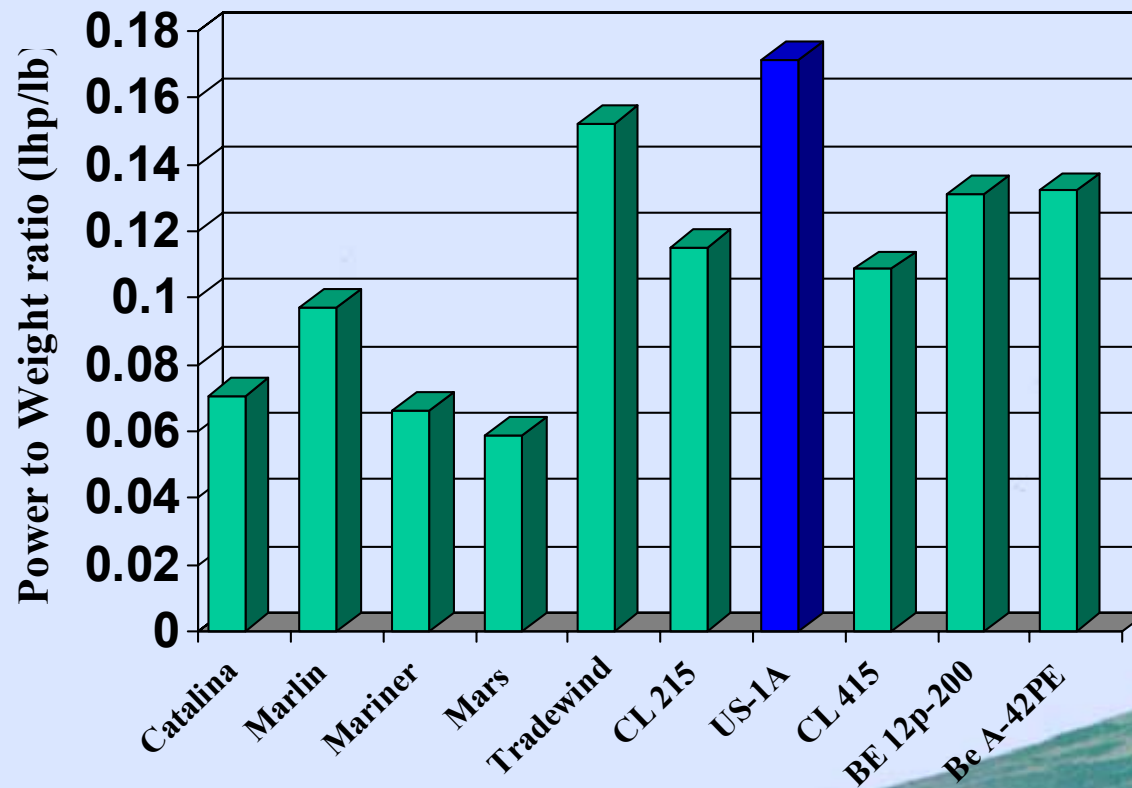
Shin Meiwa US-1A - 79,000 lb Aircraft



Rough Water Operation

Rapid take-off & landing is important

- awareness of sea surface and weather
- exploit benign patches of water
- STOL technology
- power





Rough Water Operation

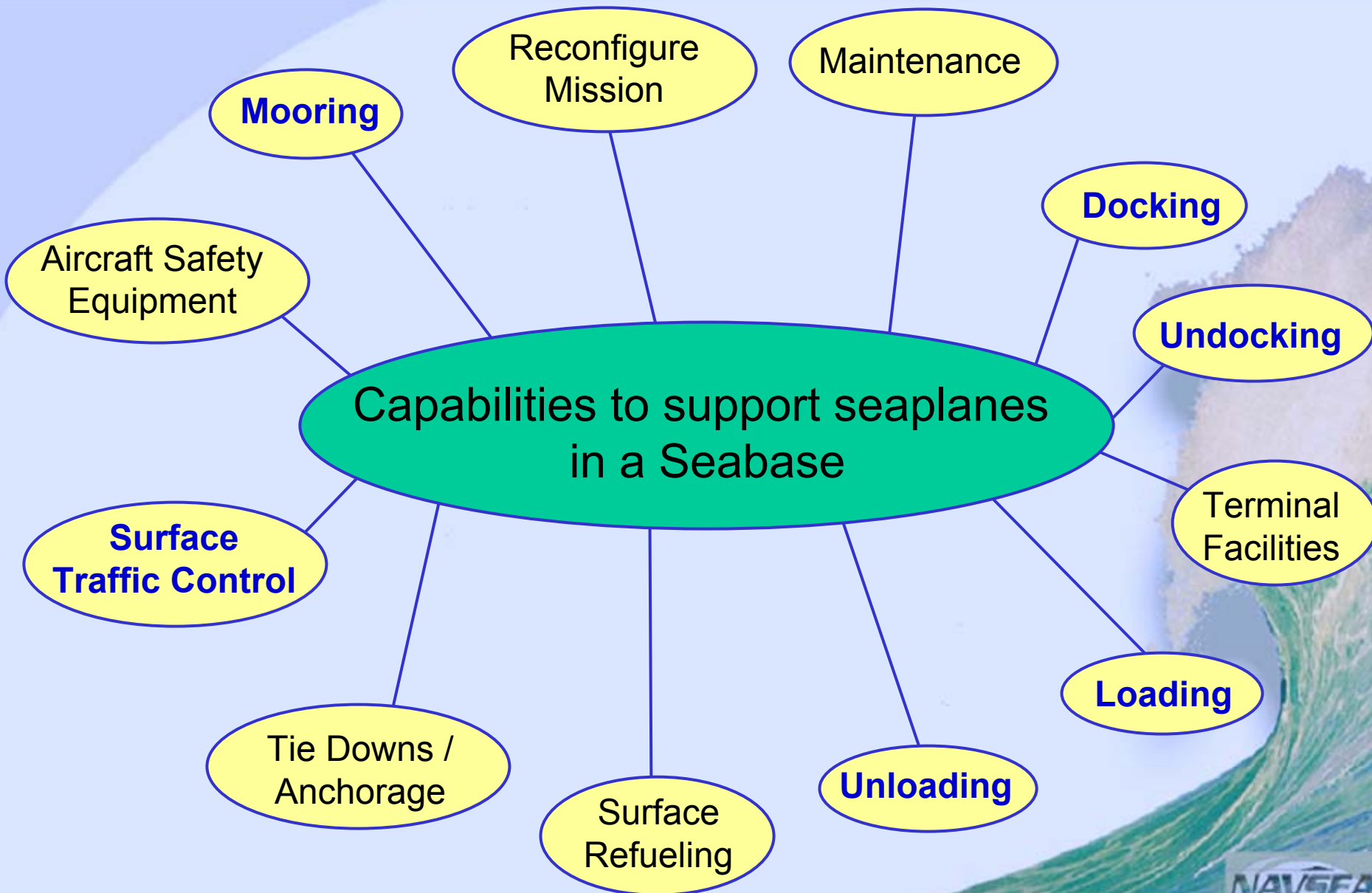
Summary

- Seabasing missions likely to require
 - large seaplanes
 - rough water operation
- Current technology suggests seaplane operations possible through SS 4 & into SS 5
- No significant investment in critical seaplane technologies for 40 years
- Potential for S&T investment
 - seaplane seakeeping theory
 - advanced hulls
 - non-conventional landing systems
 - active motion control systems
 - STOL
 - All weather sea surface monitoring & prediction



Seaplane Integration With Seabase

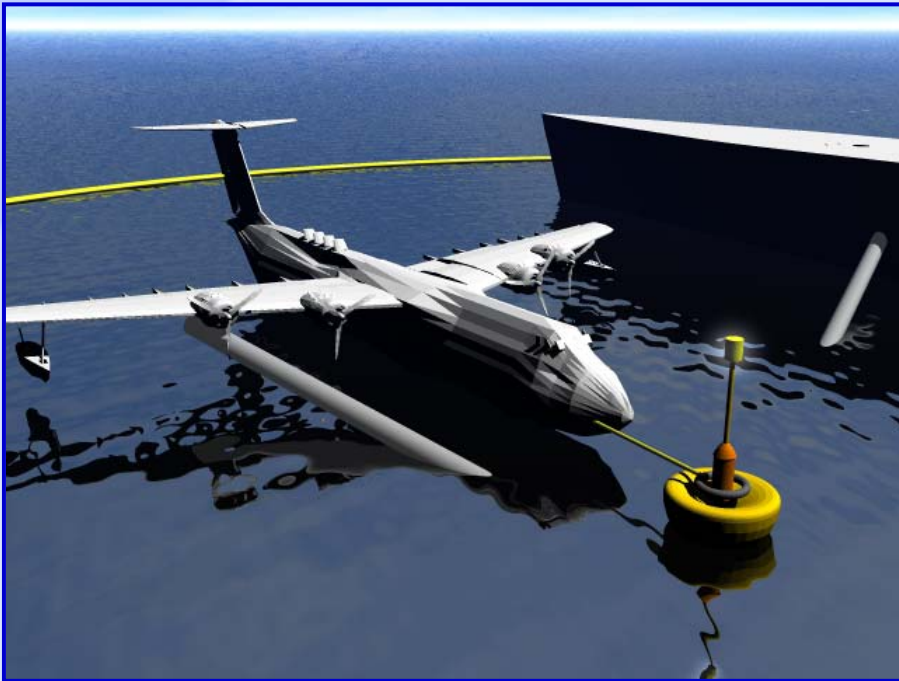
Seaplane / Seabase Integration



Issue 1: Mooring

Mooring of seaplane in water for stowage, refueling, unloading, loading, maintenance

Concept

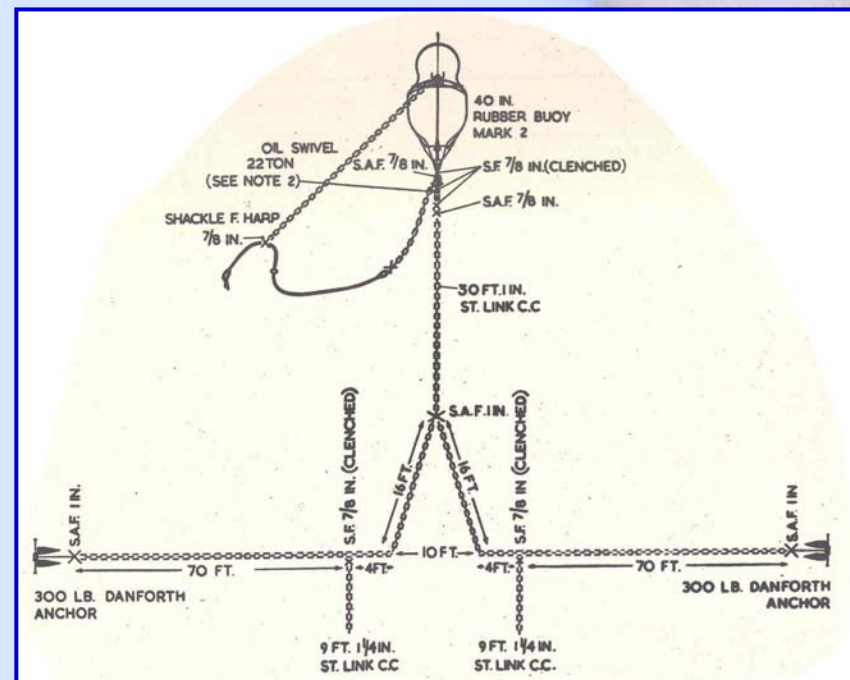


British Anti-Snatch System

- Anchor on seaplane allows it to 'snap' onto buoy
- Restoring force is a smooth function of displacement
- Proven to allow seaplane to ride out gusts of 100 knots.
- Possibility of leaving seaplane at sea.

Military Use

- Refueling aircraft – OPDS
- Stowage of aircraft
- Transfer of payload to and from seabase
- Light maintenance of seaplane
- Avoid removal of seaplanes from water



Issue 2: Docking

Transfer of equipment and personnel – one of the biggest issues of seabasing

Military Use

- Transfer of payload and personnel
- Heavy maintenance
- Reconfigure mission
- Safe haven

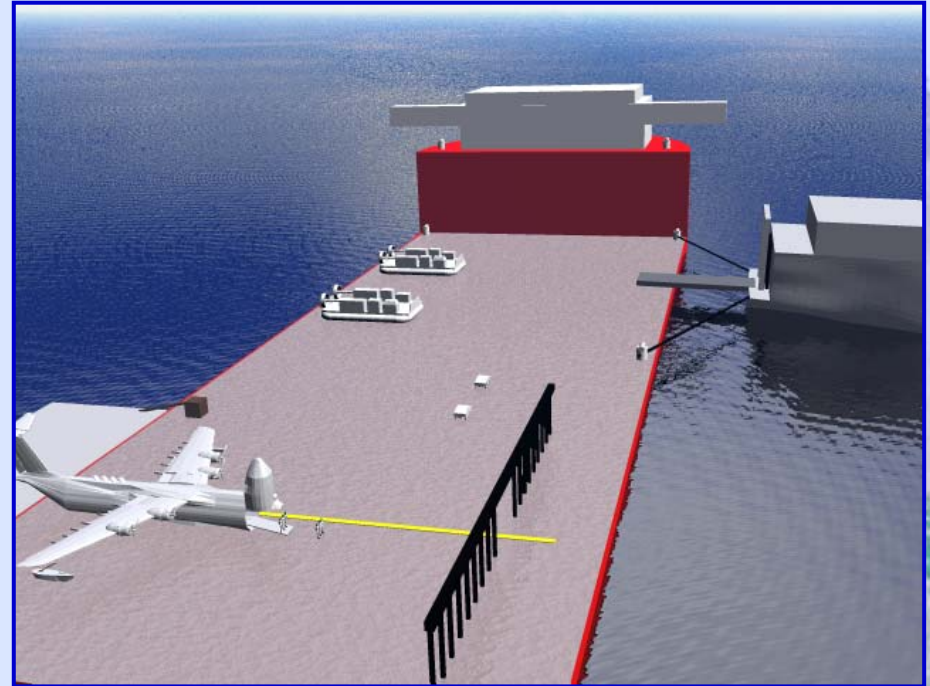
ITS Definition

- Heavy lift ship
- ~2⁰ list applied to enable;
 - LCACs to 'park' on deck
 - LCUs to drop bow ramp on deck edge
 - Minimize angle of Ro/Ro stern ramps

Features

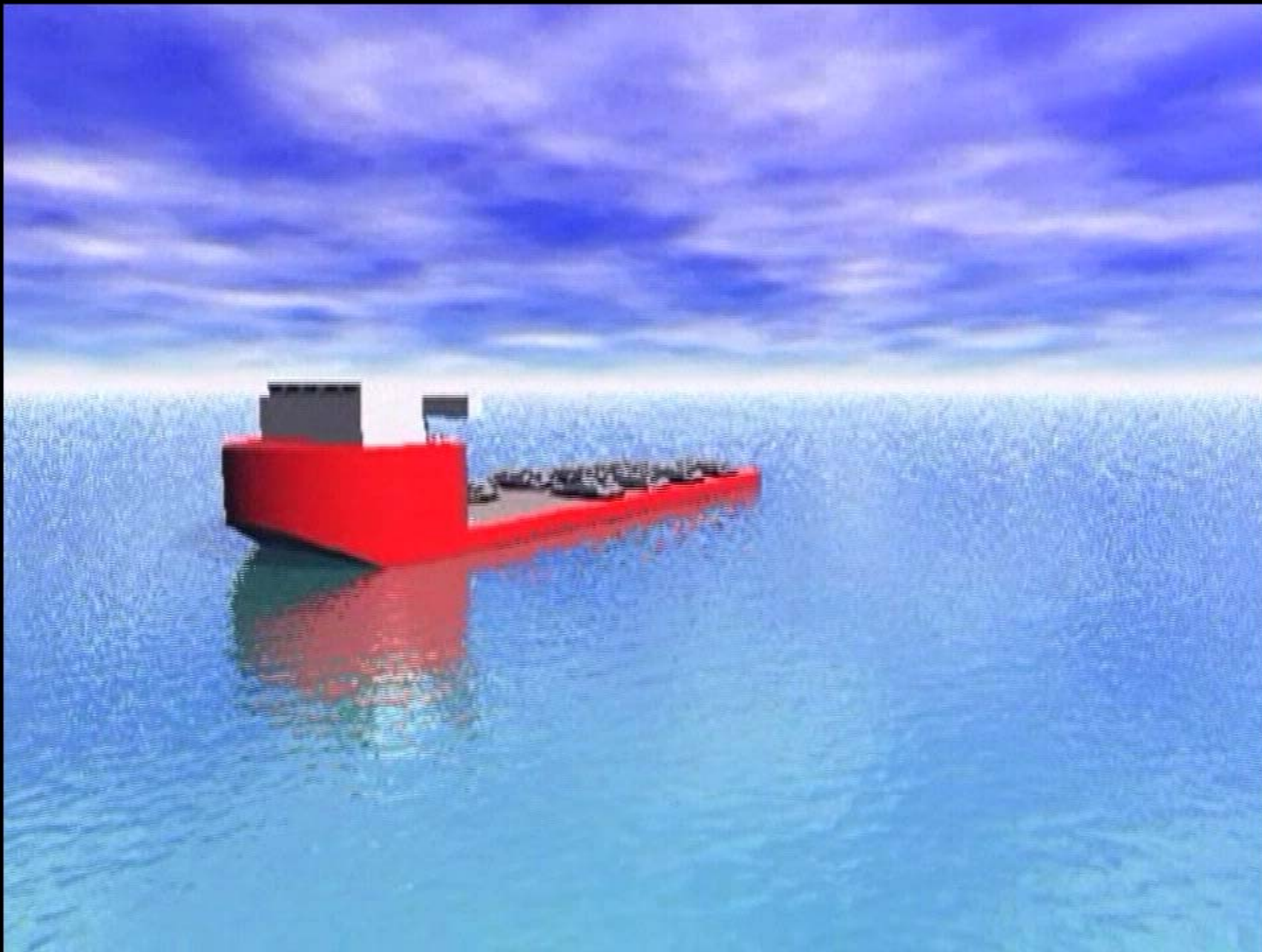
- Ramp on ITS
- Seaplane taxis up \Rightarrow crash barrier, winches
- Seaplane could be winched up
- Undocking – reverse thrust, turntable, conveyor belt
- Tiedowns / anchorage

Concept



Other Unloading Concepts

- Inverted weapons bay doors (crane)
- Bow / Stern doors (ramp)
- Detachable cargo container
- Self unloading aircraft



Issue 2: Docking

Cradle

Floating Pier

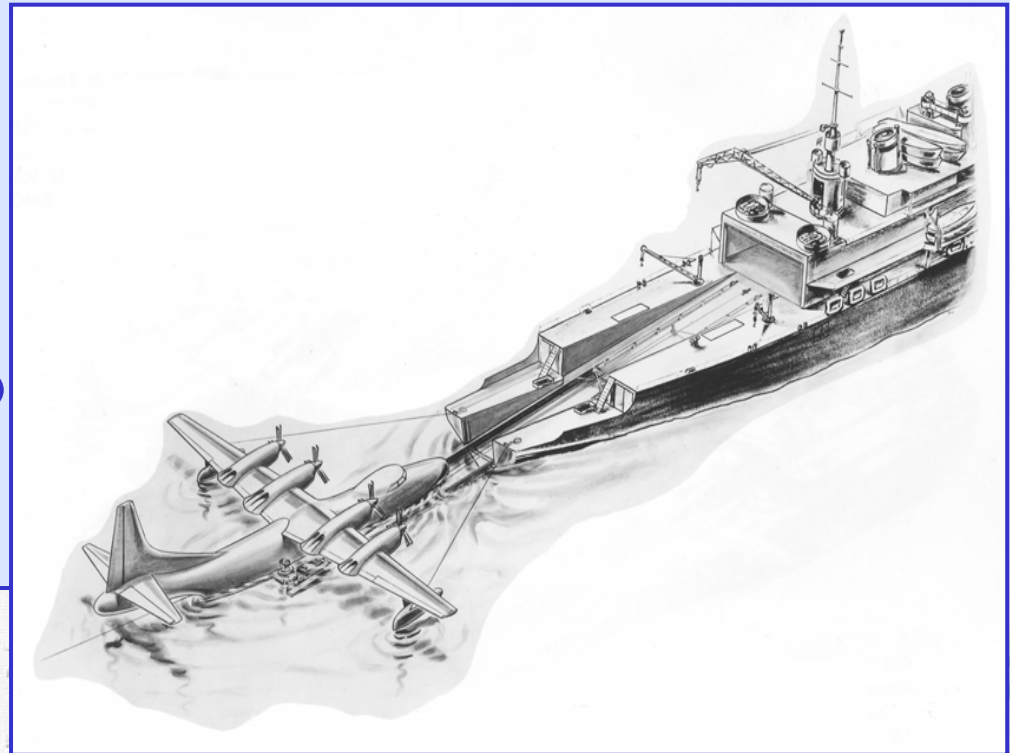
Elevator

Other Docking Concepts

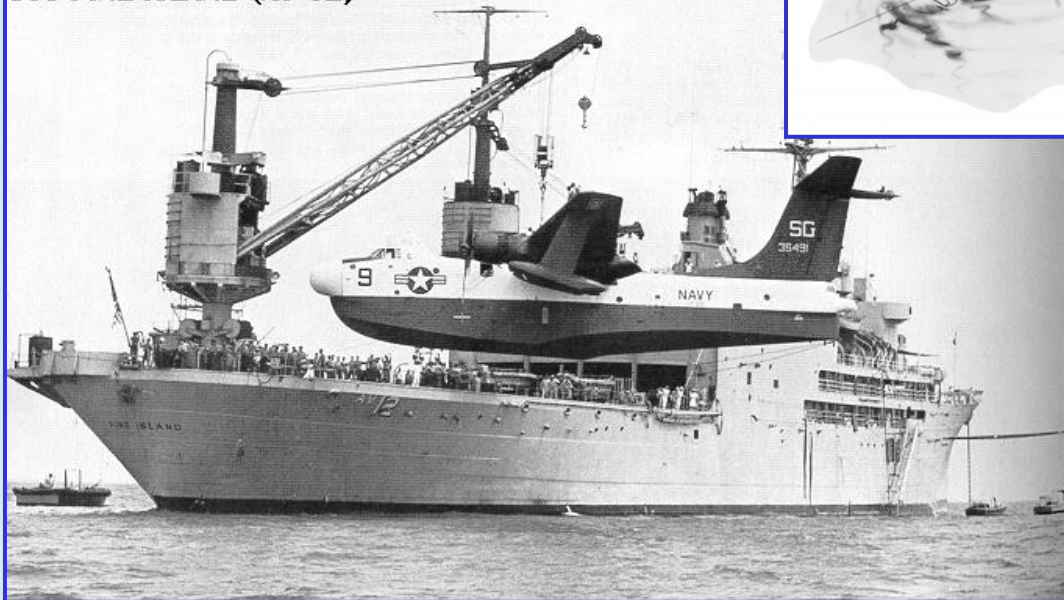
Marine Railway

Hoist

U – Dock



USS PINE ISLAND (AV 12)



Loading Boom

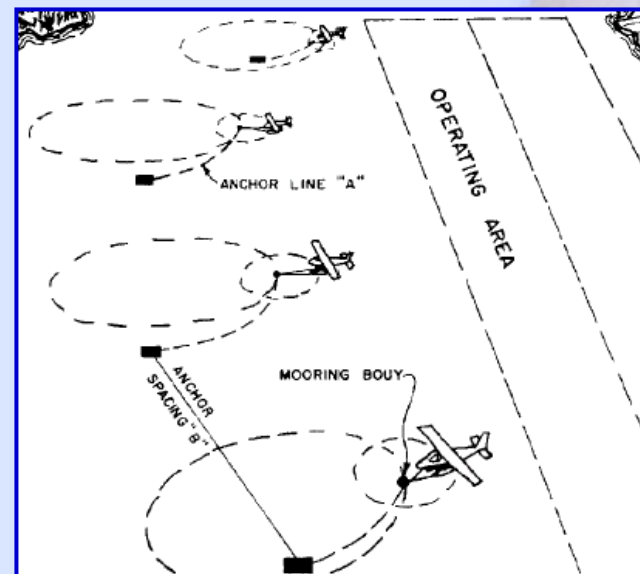
Restrain yaw and lateral
separation

Issue 3: Interaction with Seabase Environment

Concept

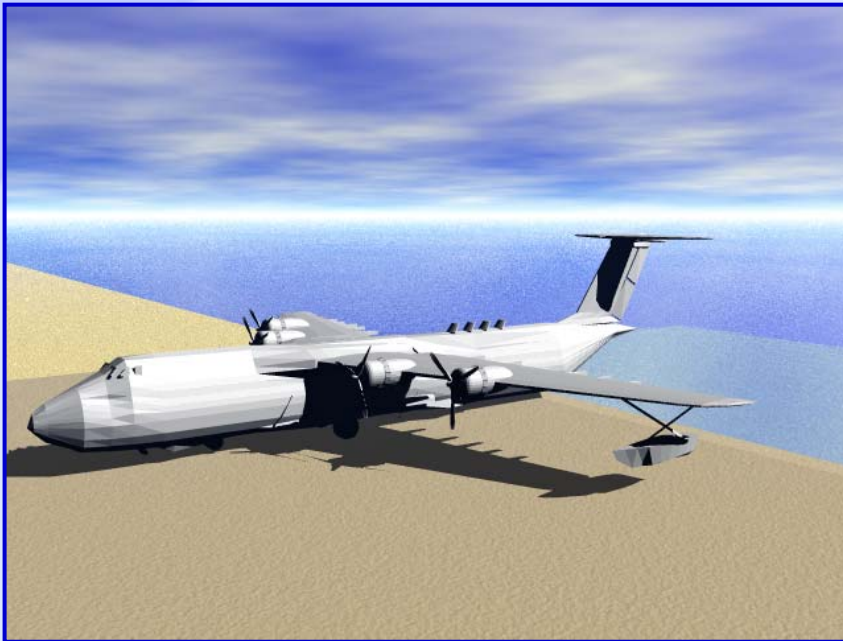
Requirements

- Surface and air traffic control – heavy seabase traffic.
- Identify landing areas, taxi-ways, parking zones – HUD's for aircraft
- Aircraft movement during the night also
 - (Submerged?) Buoys with lights
 - Floodlights
 - Ability to turn lights on and off
- Operational area management
 - pollution, intruders
 - maintenance of lights, markers, buoys
 - sea condition sensors
 - crash & rescue / salvage
 - floating debris



Issue 4: Beaching

Concept



Military Use

- Logistics delivery to shoreline
- Medivac rescue
- Civilian evacuation (humanitarian reasons)
- Joint operation use (USMC, USAF, Coast Guard, etc...)
- Maintenance

Features

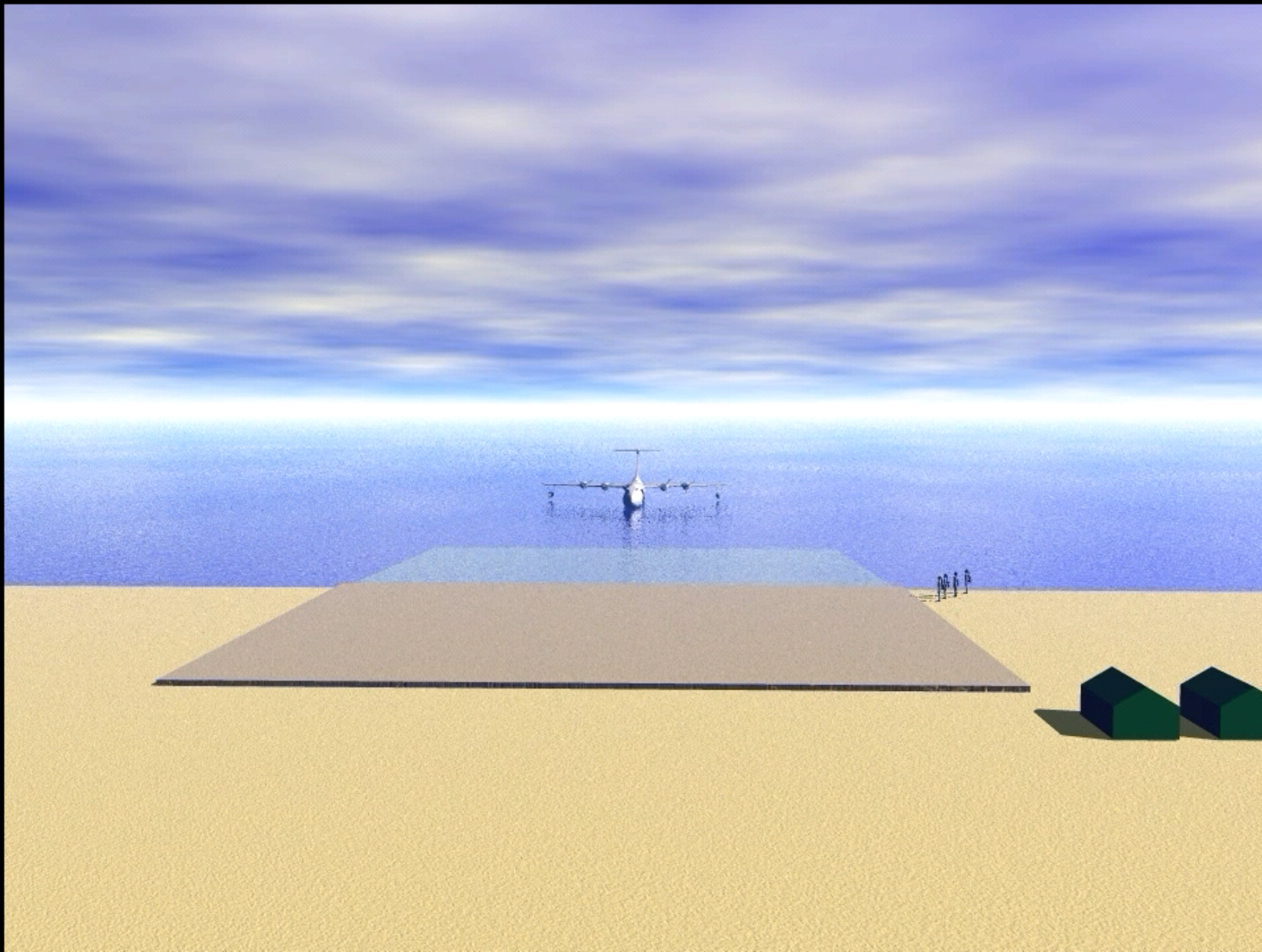
- Beaching wheels (or amphibious)
 - Advantage of not carrying cradle weight, self sufficient
- Ramp, extending into water.
- Remove completely from water
 - Compare Tradewind beaching problems

Other Concepts

- Air cushion landing system
- Floating piers

Concerns

- Not all beaches are the same – currently investigating areas where beaching is possible.



beachdocking(HIRES-Indeo5).avi



Seaplane Conceptual Design



Seaplane Conceptual Design

Primary

- Force closure
- Logistics delivery
- Refueling



Secondary

- Reconnaissance
- Search & rescue
- Para - drop

Seaplane Conceptual Design

Design Requirements

Aircraft weights & Payload

- MTOW ~ 300,000 lbs
- **Cargo :-**
30 tons (60,000lbs), **180 troops** (incl. baggage),
ISO containers (8.5' x 8' x 20'), Pallets
Army/Marine vehicles, Helicopters, UAV's, USV's, UUV's

Speed

- Cruise at **Mach=0.6** (~ 420 kts at sea level)

Range

- **1000 nm radius** fully loaded (2000 mile range)

Seakeeping

- Unlimited operations in SS4, restricted operations in SS5

Design

- Wing loading < 90lb/ft², Aspect ratio ~10

Features

- Multiple **in-flight refueling** of jet fighter aircraft
- High winged, with high mounted turboprop engines
- **Beaching gear**
- Thrust reversing
- **Fully amphibious** (alight & t/off from **land** & water)

Seaplane Concept

Aircraft weights (lbs)

- **MTOW = 252,000**
- Empty weight = 117,000
- Fuel weight = 73,710

Payload & Cargo

- Payload weight = 60,000 lbs
- Cargo volume = 5,110 ft³
- Cargo = **180 troops** incl. equip.
8.5' x 8' x 20' containers
military vehicles, RHIB's

Speeds (kts) & Range

- Max speed = 370 (425 mph)
- Cruise speed = 368 (423 mph)
- Min speed = 108 (124mph)
- Stall speed = 83 (96 mph)
- **Range = 2000nm**

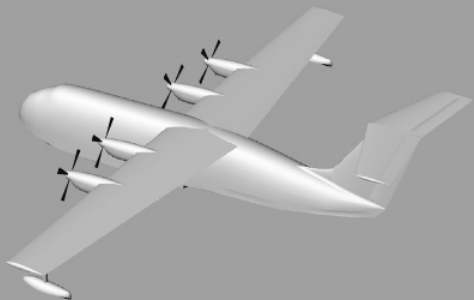
Aircraft (fuselage) geometry

- L, W, H = 144ft, 13.7ft, 25.4ft
- Wing span, b = 163 ft
- Wing area, S = 2,650ft²
- Draft = 5 ft

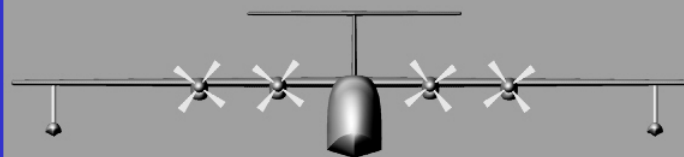
Aerodynamic parameters

- L/D = 12.5 (estimated)
- C_D = 0.0258 (estimated)

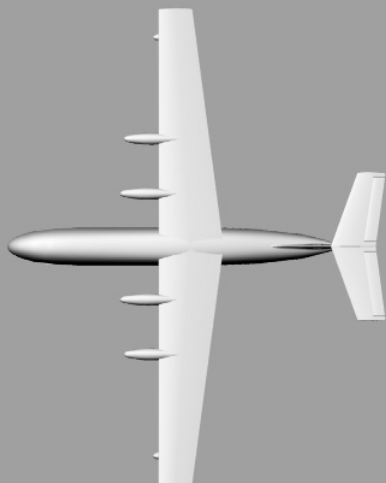
Seaplane Conceptual Design



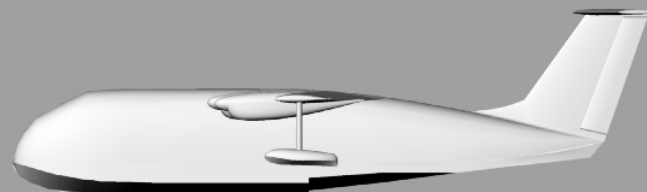
front



plan



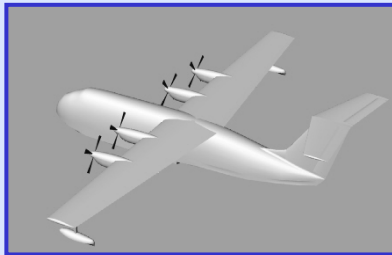
side



Comparison of conceptual design

	Shin Meiwa US-1A	C-130J	Seaplane Design Concept	C-17	C-5
MTOW (lbs)	94,800	155,000	252,000	585,000	840,000
Payload (lbs)	30,000	34,000	60,000	170,900	270,000
Empty weight (lbs)	56,200	79,291	117,000	278,000	337,935
Length / Height (ft)	110 / 33	98 / 39	144 / 43	174 / 55	247 / 65
Wing span, b, (ft)	109	132.6	163	171	223
Wing Area, S (ft ²)	1,460	1,745	2,650	3,800	6,200
Range, (nm) (with payload)	2,300	1,600	2,000	4,741	6,320
Cruise Speed, (kts)	230	362	368	450	450

US-1A



C-5



C-130



C-17





Summary

Summary

Background

- Project overview
- Seaplane (historical) development
- Importance of seaplanes
- Seaplane decline
- Renewed interest in seaplanes

Seaplane Characterization

- Functional characterization
- Seaplane database assembled & near completion for parametric studies
- Parametric data presented

Seaplane / Seabase Integration

- Identified roles and capabilities required for seaplane / seabase interaction
- Generated concepts to meet mission roles
- Seaplane - seabase interfacing ~ technical issues highlighted

Seaplane Design

- Design criteria identified
- Conceptual design of aircraft

S&T requirements

- Advanced hulls (geometry & material)
- Non-conventional landing systems
- Active motion control systems
- STOL techniques
- Reduce water spray
- Sea surface monitoring & prediction

Conclusion

- Seaplanes have a potential role in seabasing
- Advanced technology seaplane provides useful capabilities
 - Force closure
 - Heavy lift seabase to shore sustainment
 - In-flight refuelling
- S&T investment needed for advanced technology seaplane
- Integration of seaplanes into seabase raises issues
 - Transfer of personnel/cargo from seaplane is critical
- Identifiable ways of dealing with major seabase interface issues
- Evaluation through trials is recommended

